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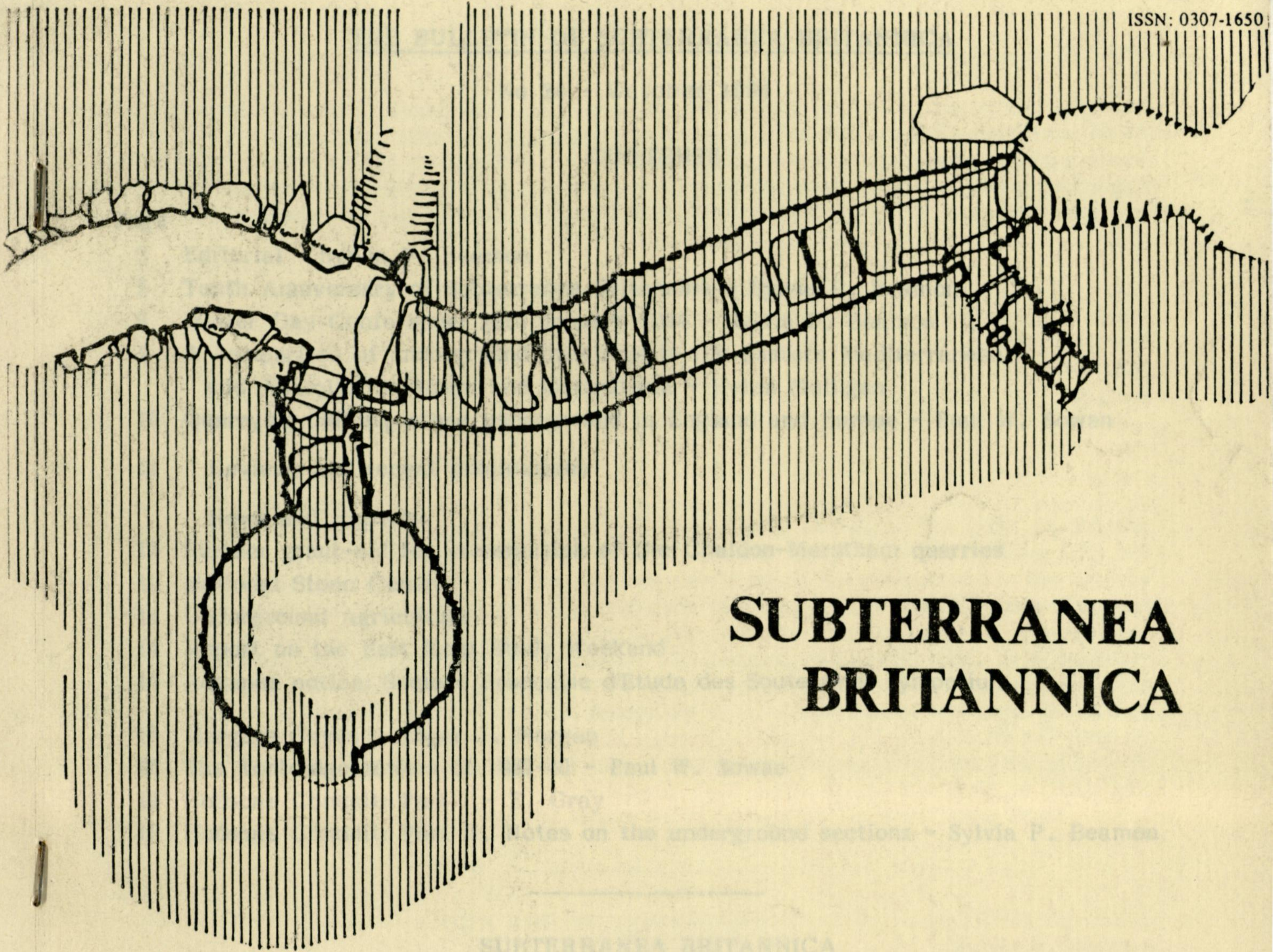

SUBTERRANEA BRITANNICA

Bulletin No. 20

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THE BULLETIN OF SUBTERRANEA BRITANNICA

No 20 - October 1984

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SUBTERRANEA BRITANNICA

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The bulletin has been compiled by Sylvia P. Beamon with assistance from Tom Doig, Rod Le Gear, Deryck Laming and Jenny Plumer.

EDITORIAL

Sylvia P. Beamon

As reported in the first Newsletter, Subterranea Britannica had been awarded a further £100 from the Lloyds Bank Fund, and in June several members attended the presentation at the Society of Antiquaries in London. Lord Montagu, who had previously given a short speech on the merits of the new Commission, presented the cheque to Paul Sowan to be put towards the purchase of equipment for the Chaldon-Merstham survey (see page 13).

Goldney Grotto

One of the best-preserved shell grottoes in England has been vandalised - that at Goldney House, Bristol, which Subterranea Britannica visited during its Bristol Study Weekend several years ago. A short report in The Guardian of 5th January 1984 tells us that "Vandals have destroyed one of the world's finest collections of rare shells... The gang broke down a heavy wooden door leading to the underground grotto..."

And now for the good news - at Dudley

Engineers have nearly completed cutting the first canal tunnel to be built in Britain since 1850. It is being driven into the side of Castle Hill, Dudley, costing £225,000 with a grant from the Department of the Environment's urban aid programme. The Dudley Canal Trust which put forward the scheme, believes that more than 150,000 tourists a year will take boat trips through the tunnel to view the massive Singing Cavern, created and left by limestone miners in the last century. The tunnel, 200 yards long, is a replacement for an original tunnel linking to an underground canal across the cavern floor. This original tunnel is blocked by rubble (the delegates at the 1984 Study Weekend at Dudley climbed over this to gain access to the main cavern). Nearly 200 yards (180 m) long by 50 feet (15 m) wide and 60 feet (18 m) high, the cavern is supported by five pillars of natural rock. Those who attended the excellent East Kent Study Weekend in June will recall the 'History in the Making' slides shown by members of Dudley Canal Trust.

OUR TENTH ANNIVERSARY

Sylvia P. Beamon

On this, the occasion of our tenth anniversary I have been asked, as founder of Subterranea Britannica, to write a short summary of its inception. In fact 'birth' is a more appropriate word, for, ten years prior to 1974, I was an ante-natal teacher for the National Childbirth Trust and, during that time, I was also researching the Royston Cave, technically what the French people call a "souterrain amenage" or as we tend to do now, a man-made, man-used under ground structure. Over a cup of tea at the end of each lesson when the conversation turned from 'babies', discussions took place on history and my 'hobby'. My work on this unique cave brought me into contact with Dr R.C. Smail of Sidney Sussex College, Cambridge, and Prof Raymond Mauny, of the Sorbonne, Paris and President of the Souterrain French Society. Both encouraged me to form the society, and in fact it was Professor Mauny who formulated the title Subterranea Britannica.

Adey Horton, whose home is a complex of caves at Troo, Montoire, France, but used to live in London several months a year, has the honour of being the first official member of the society. He showed his confidence in my endeavours by advancing his subscription prior to the first meeting.

The Inaugural Meeting of 21st September 1974 at Emmanuel College, Cambridge, was chaired by Dr Smail. The task set for the new society was to pioneer and promote research in the recovery of artificial underground structures and to formulate an inventory of them County by County by studying old maps, books, historical and archaeological journals, oral traditions, to learn the necessary techniques in order to establish recovery as there are difficult and different conditions underground, where the expert knowledge of potholers and speleologists would be (and have proved to be) of great value.

Our Tenth Anniversary (continued)

Subterranea Britannica was, and still is, open to all, like its Continental associates at that time, Societe Francaise d'Etude des Souterrains, and Arbeitskreis fur Erdstallforschung. It was not necessary to be professionally concerned to join, so anyone who was interested in the subject was most welcome. The initial members of Subterranea Britannica were made up predominantly of the parents from my ante-natal class who came to support my endeavours to launch this new society. Shortly afterwards Prof Glyn Daniel agreed to be our President for a term of three years.

In the Autumn of 1976, a suggestion by Dr John Alexander of St John's College, who incidentally still co-edits the Bulletin for us, and who was Chairman for four years, was to try and expand the society to incorporate other societies in a Federation of Subterranea Britannica. The larger caving groups were, on the whole, well established and felt they had little to gain from affiliating with us, and later we were to revert to our original name, but expansion both here and abroad has always continued, not hurriedly but consistently. We have two representatives on the Council for British Archaeology, several libraries and museums take our Bulletins, exchange membership grows thereby disseminating information; our annual Study Weekends have proved most successful and the numbers attending increase yearly. There are opening opportunities for visits to the Continent for comparative study.

Although I have now resigned from Chairmanship of the Society, this does not mean I have lost impetus or interest, but the Committee is strong. This, therefore is the right time for a change to ensure new blood with new ideas. I have no doubt at all that Subterranea Britannica will go from strength to strength.

WINTER DAY CONFERENCE: 28th January 1984

Sylvia P. Beamon

The venue for the Winter Day Conference was, as usual, "Strathaird", Lucy Cavendish College, Cambridge.

The opening speaker was Dr Peter Leggo, formerly with the Department of Geodesy and Geophysics, Cambridge University, who explained Subsurface Georadar, the particular field in which he had been working for three years. It was a study of low and high energy wave changes through the earth to locate anomalies, such as pits, that could be graphed. From experience the profile could be read, but there were problems according to different soils; and velocity variations, even in the same medium, could occur. No doubt for underground location, this research work and its application should be kept foremost in the society's searches.

Helen Mulligan, a research student at the Martin Centre for Architectural and Urban Studies, Cambridge University, followed with a most enlightening and illustrated lecture on the comparison of Rock-cut Underground Dwellings of the Eastern Mediterranean: Cappadocia and Santorini (see pp. 4-9).

After lunch, John Vigar spoke on Underground East Kent, which was most appropriate as many members would be attending the East Kent Study Weekend in late Spring. Amongst sites he discussed were the Chilton Farm passages leading from the cellar, function unknown, therefore speculation was high - a folly, used for smuggling perhaps? - etc. Illingsworth Tunnel has also been relocated, and an article on this will appear in a future Bulletin.

Brief Communications: Paul Sowan gave a preliminary report of his visit to various quarries similar to Merstham, and in particular Chilmark and Teffont. Richard Perkins illustrated his talk with slides on the ice-houses of Derbyshire. Ken Geddes' short summary on the canal tunnel at Dudley brought the afternoon proceedings to a close.

A COMPARISON OF UNDERGROUND DWELLINGS IN THE EASTERN MEDITERRANEAN AND ANATOLIA: SANTORINI AND CAPPADOCIA

Helen Mulligan

Introduction

The incidence of rock-cut cave communities is widespread both in space and time. Two regions, in which the marrying of subterranean architecture to a spectacular natural landscape provides a heritage full of interest and delight for curious visitors, lie some 800 km apart in the eastern Mediterranean. They are the island of Santorini, most southerly of the Green Cyclades, and the former province of Cappadocia in the heart of Anatolian Turkey.

Although geographically unlike in situation and at present separated by a national frontier, these two regions share a tradition of troglodytism which has developed under cultural influences which, for a significant part of their history, have been very similar. In the light of renewed interest in the potential benefits of underground housing, particularly with regard to the more efficient use of energy sources, the study of the motivating factors leading to the adoption and utilisation of an underground habitat can be of great interest to contemporary designers.

Santorini

Santorini is the most southerly of the Cycladic islands, lying some 100 km to the north of Crete, 250 km southeast from Athens and a similar distance southwest from the Aegean coast of Turkey. Volcanic in origin, the island suffered a calamitous eruption about 1500 BC when its cone exploded with a force approximately three times greater than that which destroyed Krakatoa in 1883. The central caldera was submerged by the sea, and what remained of the island blanketed by a layer of volcanic ash 30-40 m deep. The Late Minoan city at Akrotiri, on the south coast of the island, was buried and its culture utterly destroyed: its sister civilisation, centred on Knossos in Crete, suffered a similar fate a few decades later, perhaps caused by associated seismic events.

Santorini now consists of a ring of outer islands - Aspronisi, Thirasia and Thira, by far the larger and most important - which present a forbidding coastline of sheer cliffs to the encircled caldera where the young rocks and hot springs of the two Kameri islands give evidence of continued volcanic activity. They are fringed by black volcanic beaches on their outer shores, separated by headlands like that between Kamari and Perissa to the southeast of Thira, on which was sited the near impregnable city from which the island was ruled in Hellenistic times. Among the ruins of theatre, palace, temples and shops of Old Thira may be seen tombs and water cisterns hollowed from the rock. A natural cave, with masonry additions, served as the sacred place for the cult of Hercules and Dionysos. Nevertheless, there is no evidence that the inhabitants of this rocky citadel carved out any dwelling-places underground.

In the early medieval period the island formed part of the Byzantine Empire. By the end of the 12th century, however, imperial hegemony in the Aegean had weakened to such an extent that Santorini fell under the control of pirates for whom its sheltered lagoon provided an ideal base. Order was restored by Crusader forces under Jacques Barotsi who, in 1244, took over the island on their return from the Holy Land. Five fortress towns were established at Thira, Oia, Emporion, Akrotrion and Pyrgos on vantage points in the island's interior, and commanding the inner harbour from the basaltic cliffs above.

The junction between dark basalt flows and lighter underlying strata has been particularly favoured for excavation of deep, narrow homes and storehouses. The resulting narrow frontages gave a compact settlement with a minimum of exposed perimeter to be defended by city wall. It is also claimed (ref. 12) that these closely-packed buildings embedded in the homogenous pumice-like Thiraki-gi rock, provided buttressing support which minimised the devastating impact of earthquakes which have periodically shaken the island, most recently in 1956. Much damage attributed to seismic shocks can however be observed in the number of abandoned buildings on the island.

By the 18th century the density of underground development was such that local bye-laws were necessary to control further aggrandisement: "the owner of property neighbouring one which is partly dug into the ground may not extend his house if there is any risk of touching the adjacent dwelling... the owner of a garden may not plant trees if his garden is situated directly above a house." The inhabitants of Santorini are still reluctant to plant flowering vines to shade their terraces, least they should cause damage to adjoining cave-dwellings and cisterns.

The development of the typical 'monospito' dwelling-unit on the island may be traced from excavated cave to semi-subterranean dwelling to barrel-vaulted masonry house. Stone blocks extracted during excavation of the cave rooms were used to construct erosion-resistant facades, and then cave-shaped outer rooms whose vaults may support terraces for drying agricultural produce. A typical contemporary home, therefore, consists of one or more monospito units situated partly below ground and partly above. The basic unit has two rooms, one behind the other, separated by a 500 mm thick masonry wall which, like the façade, is punctuated by four openings rebated as if to receive joinery: a central door, with a window above and one to each side. It is possible that this dividing wall represents, in actuality or convention, an earlier facade in the plane of the cliff-face. The dwelling frequently consists of two parallel monospito units, either side by side or one above the other; internal connections are rare. The second monospito can thus function as accommodation for a junior branch of the family, or as a stable. Out buildings contain latrines and kitchens, the latter often equipped with ventilation shafts to maintain a ventilating air flow through the house. Mortar and external render consists of 'theraic cement', a mixture of lime and pozzolanic earth in proportions varying from 3.5':'1 to 8':'1 which produces results similar to the Roman cements manufactured from volcanic ash deposits mined around the Bay of Naples.

Recent studies have shown how successfully these semi-subterranean dwellings maintain an equable internal temperature. It has been shown that diurnal temperature variations of 30° outside can be reduced to 5° or less due to the moderating influence of earth-coupling (ref. 1). Comparing measurements taken in the inner and outer monospito rooms, it can be seen that deep inside the dwelling temperature fluctuations can scarcely be felt, while the outer rooms experience more variation. This can be attributed to heat gain by direct radiation (i.e. sunlight) shining into the room, and closer linking to external air temperatures due to ventilative exchange.

The role played by the poor thermal conductance and high capacitance of the surrounding rock in levelling out peaks and troughs in ambient temperatures has been convincingly modelled by a team of researchers at the University of Venice (ref. 5). Their computer prediction of hourly temperatures over a summer's day was validated by actual readings taken in a dwelling on Santorini. The model can thus be used with confidence to estimate temperatures in such a dwelling throughout the year.

The climate of Santorini, although moderated by the surrounding sea, experiences sufficient extremes of heat and cold, from summer daytime to winter night, for this internal temperature stability to be much appreciated by inhabitants of semi-troglodytic houses.

Cappadocia

Very many of the villages scattered across a wide area of the Anatolian plateau make extensive use of underground space for storage and habitation: frequently these subterranean rooms are now almost totally concealed from superficial view by more recent construction. From Cappadocia, this semi-troglodytic zone extends eastwards as far as Malatya, and nearly to the Syrian border in the south.

It is in the region between Nevsehir and Kayseri, however, that the interaction of man and the natural landscape has produced the most dramatic and justly celebrated results; the late Tertiary epoch geological activity covered the land with a layer of volcanic tuff, in places over 1200 m thick, and threw up the cones of Eriyas (Mount Argaeus) and Hasan Dagi which dominate the area today. The tuff, however, has proved vulnerable to erosion by water and wind: the region between the volcanic peaks has been eroded into a fantastic landscape of rippled ravines, rock castles and, where the tender stone has been protected by a basalt cap, the extraordinarily tall and slender 'fairy chimneys'.

It is not surprising that this strangely favoured land attracted inhabitants at an early period. By the 7th millenium BC (as evidenced at Catalhoyuk), the Anatolian plateau was perhaps the most culturally advanced region of the world, and the Nevsehir-Kayseri region by virtue of its geological makeup offered a hospitable environment for early man. The land was comparatively fertile, the broken terrain inherently defensible, and the weather-worn rock provided sheltering hollows which could, as later inhabitants were to find, very easily be enlarged and adapted by human agency.

The earliest evidence of cave-inhabitants within this area can be dated to around 3000 BC. By the Hittite era, which began about a thousand years later, it is thought that some man-made caves were being excavated. Whatever conclusions may be reached on the evidence for pre-Christian cave dwelling in Cappadocia, the importantance of Christianity in accelerating the development of this habitat must be emphasised. The greatest achievements of Cappadocian troglodytism may be seen in the splendidly sculpted plastered and painted churches, particularly of the Goreme district. Together with their attendant monastic facilities, such as refectories, kitchens and washrooms, isolated hermitages and congeries of cell-like dwellings, these structures represent a very large and undoubtedly influntial class of building types.

What were the factors that caused Cappadocia to become such a centre of Early Christian culture and artistic achievements under the Byzantine Empire? The answer must lie in the unique opportunities offered by the terrain for both mysticism and concealment. The bizarre landscape struck all travellers with awe, and must already have inspired tales of association with the supernatural.

And so when, in the 3rd century, the ascetic life acquired such mass appeal that thousands flocked to monasteries in the wilderness in preference to secular life in the corrupt and dissolute cities of the Near East, Cappadocia became something of a magnet for the self-exiled. In solitary hermitages the early recluses emulated the tribulations suffered by St Anthony and other ascetics in the deserts of Egypt and Syria: in monastic communities the Rule of St Basil (330-379 AD) ensured that the believers met together, at least on feast days of importance, to confirm in one another the fundamentals of the faith.

As for concealment, the chequered history of the Church in Asia Minor repeatedly occasioned the need for an unobtrusive hideout in which, should the worst happen, a defence could be maintained under siege. Both internal conflicts within the Empire and pressure exerted by external foes can be seen to be associated with renewed troglodytic activity. And when these troubles coincided, as in the mid-8th century, it seems that underground construction received a double impetus.

Hard-pressed by the dual threat of marauding Arab tribes and zealous iconoclasts, the beleaguered monks melted away from the face of Cappadocia. Some fled to more hospitable lands: it is estimated that between 726 and 775 AD up to 50,000 brethren emigrated to Italy, taking their troglodytic tradition with them to settlements in Apulia and Calabria such as Matera and Massafra. Others simply went deeper underground. Subterranean "cities" have been discovered, Derinkuyu, Kaymakli and four other locations in which something like 20,000-60,000 people could withstand a siege: ventilating shafts, wells, food stores and wine vats are included in the accommodation, together with secret guardrooms, blind passages and trapdoors for defence purposes. Although older artefacts, even at Derinkuyu, a Hittite quern, have been uncovered in the exploration of these cities, it is most likely that the larger part of these works was carried out in the troubled period from the late 7th century to 900 AD, as is attested by the rock-cut churches found within them. When more settled times returned, caves were not abandoned: the rock-cut churches which received the new, ambitious schemes of decoration, and rock-cut dwellings which Leo the Deacon remarked on as the most ubiquitous and characteristic habitat of the region.

This cultural flowering, however, came to a sudden and unexpected end. In 1071, at the Battle of Manzikert in northeastern Anatolia, the Emperor Diogenes was defeated and captured by Seljuk Turks under their leader Alpaslan. Fragmented groups of Turkoman tribesmen, who neither owed allegience to the Seljuk Sultans nor practised orthodox Islam, occupied the plateau. The Byzantine administration was hamstrung: the Empire limped along until the fall of Constantinople in 1453, but despite Turkish tolerance of the culture and religion of indigenous peoples, Byzantine art and architecture lagged; and although many Greek-speaking communities continued to worship in their rock-cut churches until the Turkish-Greek mutual population exchange of 1923, the lack of official support for their faith jeopardised the maintenance of many distinguished works of art. Private dwellings, however, suffered no such loss of esteem, for the quality praised in the 13th century by the author of the 'Synopsis Chronike' is still appreciated today.

As indicated by Stirling (1965), a large proportion of the domestic venacular buildings within this region have at least part of their accommodation below ground level. A fine example, illustrated below, is present by Evrencin (1979) the house of the Imam, or prayer leader, in the village of Avcilar.

How typical this semi-troglodytic arrangment may be seen from Mahmut Makal's description of his own family home at Demiryi, some 50 km to the west of Avcilar:

"Our stable is in the back part of the house and the barn too, is in the inner part of the stable. There are three roofs, one below the other. The stable and the barn are old caves carried out of the ground. Up to within a few years ago the house in which we now live didn't exist, and when he was much better off, my father had this house built in front. Th old house which remains on the inner side has become the stable."

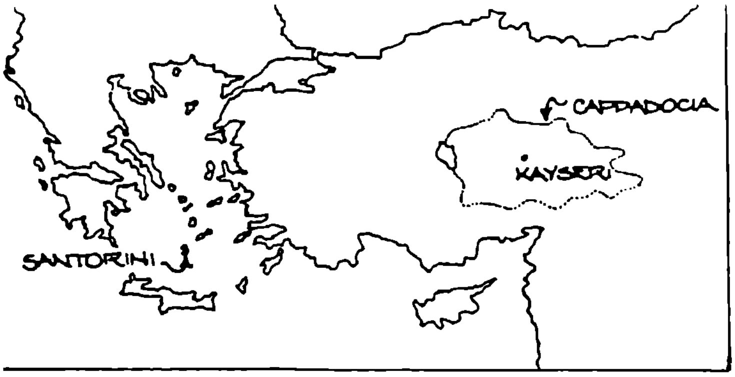
The cave-dwelling is thus undergoing a change in usage over time, which contrasts with the recurrent use-patterns obtaining as described below, over diurnal and yearly cycles. The cave-as-house, however, is still seen as the original core of the home and as such is associated with intimate domestic rites: for example the bride-dressing preceeding a marriage ceremony, at which the young woman is bidden farewell by her female relatives before becoming a member of her husband's household, traditionally takes place in an inner cave-room of her paternal home.

Those caves too, which are normally used as stores, may serve as refuges when the above-ground living quarters are made temporarily uninhabitable perhaps by inundation and roof collapse (Stirling, 1965). Being less vulnerable to natural disasters, the caves provide a permanent base for the household while the more recently constructed rooms are repaired or modernised.

However, even under routine circumstances, the use of spaces in the house, whether excavated or constructed, changes from day to night and summer to winter.

The Anatolian village house combines the functions of home, workplace and, very often, public meeting hall. One part of the house forms tool sheds and stores for agricultural implements, stables and associated barns for storing the chopped straw which feeds the animals. Another part is given over to social activities: this is the guest room in which weddings and feasts are celebrated. In the richer and more influential households, this room is the social centre in which the male kin and close associates of the household head will pass much of the afternoon: most villages have no public buildings beside the mosque and schoolhouse, and so village affairs are debated and wider social relations maintained by these gatherings.

The third part of the house is the family home, the preserve of the women and children. Casual visits from female friends and relatives will be received here, but according to Islamic concepts of propriety male strangers must not intrude upon the privacy of this zone.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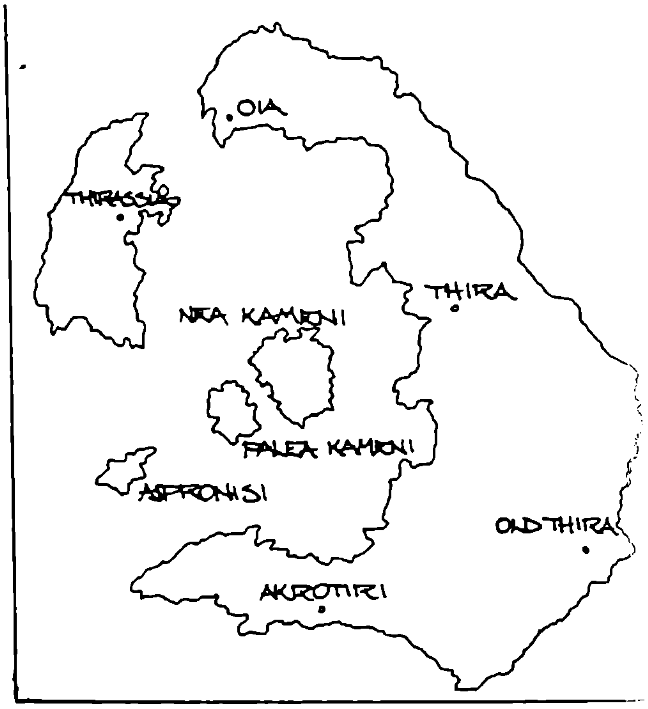
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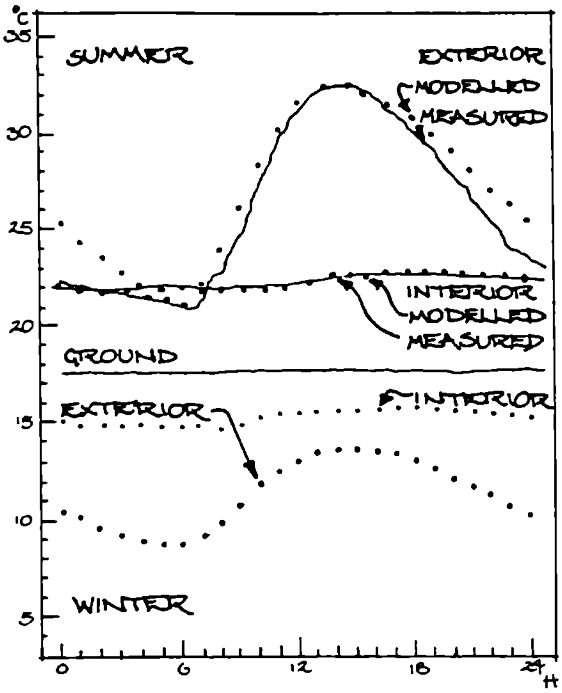
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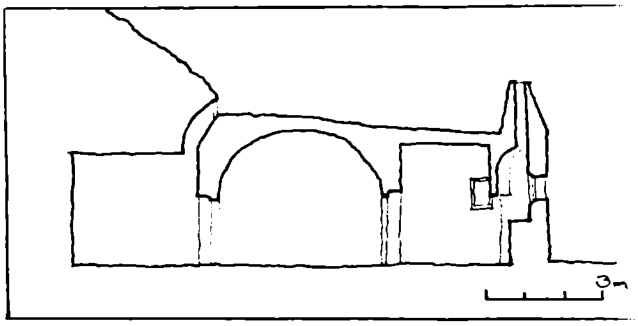
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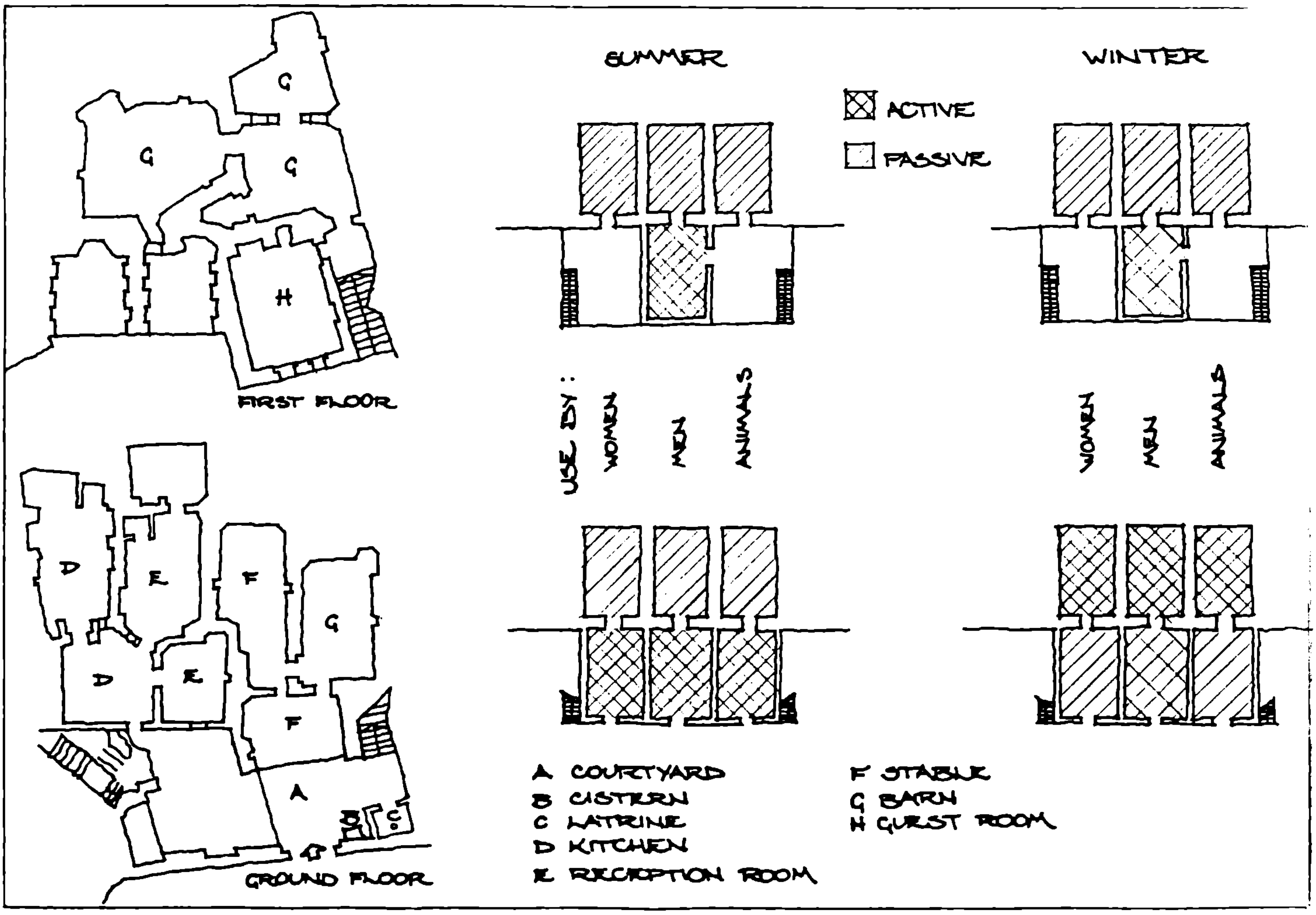
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A COURTYARD
B CISTERN
C LATRINE
D KITCHEN
E RECEPTION ROOM
F STABLE
G BARN
H GUEST ROOM

The house is thus quite strictly divided up between the women, the men and the animals. The living rooms are used also for sleeping, the bedding being stored in cupboards during the daytime. Rooms are thus used throughout the 24 hour day, but not throughout the year: each zone is provided with rooms specifically for summertime or wintertime use. At any one time, less than half the house will be in "active" occupation - storerooms may be considered "passive" for each season.

It may be seen that the caves are reserved for active use in winter, when their characteristic thermal equilibrium ensures an internal temperature higher than that of an unheated room above ground. Correspondingly, this property will also ensure that the summertime cave temperature should be lower than that experienced in the constructed part of the house during the day. Account must be taken, however, of the cooling effects of breezes on internal temperatures within the well ventilated summer rooms. It seems that the preferred method of environmental control in summertime is by ventilation, rather than reliance on the moderating influence of the ground which could be enjoyed within the caves.

The environmental benefits of underground living are, therefore, most appreciated in winter when they may give a considerable saving on scarce fuel supplies. The practice of occupying the same room for day and night contributes towards this energy efficiency.

This energy-conserving lifestyle may be contrasted with a set of theoretically derived design guidelines recently proposed for underground construction in continental-type climatic zones, including Turkey:

"the proposed house should be designed for year-round use, with interior spaces changing their functions with the seasons. In the semi-subterranean house there are two sections distinguishable by level and function:

> "1. the semi-subterranean and subsurface sections which are to be used primarily throughout the summer season when the temperature is high, and
>
> "2. the above ground sections which are to be used primarily throughout the winter season when temperature is low..." (ref. 7).

One wonders what life-long cave-dwellers would make of this proposal for a complete inversion of their annual routine.

Conclusion

It seems that Santorini and Cappadocia, both for some centuries incorporated in the Byzantine Empire and later coming under Ottoman domination, owe their tradition of a troglodyte life-style not one to the other, but both to a common source in the Near East. This form of habitat was introduced in the one case by Crusader warriors, in the other by St Basil and his acolytes from the deserts of Syria and Sinai.

In both Cappadocia and Santorini, cave dwelling was enthusiastically accepted for reasons of defence, and continued in more peaceful times because of the thermal advantages it offered. Vernacular underground dwellings have evolved over the centuries in direct response to their climatic situation, undergoing modifications in form and pattern of use to maximise the environmental benefits obtained by their inhabitants. The study of such dwellings, in consequence, can provide a very important check on new hypotheses about the theoretical performance of subsurface buildings and new proposals for construction programmes.

Acknowledgements

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Underground Dwellings in Santorini and Cappadocia (continued)

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(see p.21 for illustration captions)

QUARRYING BUILDING STONE UNDERGROUND IN ENGLAND AND EUROPE

(A paper presented at the SFES Symposium, Anneau, July, 1982)

Paul W. Sowan

Building stone has long been quarried underground in France, and many such quarries are still active or have only recently been closed. Perhaps for this reason, little research appears to have been done on their origins. It is formally suspected, but has yet to be established, that the techniques of quarrying underground came to England from France, and had arrived in France from classical Roman or Greek times. Almost all the published research on subterranean mineral working in the classical world relates only to metalliferous mining.

In England only one or two underground stone quarries remain in use, although others survived into the first part of the 20th century. Research has commenced on the origins and development of a number of these quarries, although it is often difficult to disentangle extensive 19th century workings from others of genuine antiquity. Although metalliferous mining was certainly undertaken underground in Britain by the Romans, there is no evidence for underground stone quarrying until perhaps late Saxon or immediately post-Conquest times. Geological and geographical conditions in England were less favourable for quarrying ashlar (fine accurately squared stone for walls) or freestone (fine stone suitable for ornamental carved work) than in mainland Europe.

London, situated in an extensive area of river gravels, clay, sands and soft chalk, had no source even of rough building-stone immediately to hand. Roman London drew on Kentish ragstone, brought by water from the Maidstone district of Kent via the rivers Medway and Thames. To a small extent from later Saxon times, and to a very large extent during the Norman and Mediaeval periods, London derived much of its stone for fine ashlar and carved work in its principal monuments from the Upper Greensand bed (Upper Cretaceous) in the Surrey parishes of Chaldon, Merstham and Reigate. Quarries in these places feature prominently in extant Mediaeval building accounts. This 'Surrey firestone' (it also has refractory properties, hence the name) is a calcareous sandstone with accessory mica and glauconite. Being readily identifiable, its distribution in use (geographically and through time) can be easily ascertained from archaeological and architectural evidence as well as from documents. Firestone does not resist the weather well, and has been extensively replaced even in the internal parts of many London buildings (for example in Westminster Abbey).

Strangely, Surrey firestone was in direct competition throughout much of the Norman and Mediaeval periods with far superior stone, at no greater cost, imported from Caen in Lower Normandy, France. A comparison of the Caen and Chaldon quarries poses the question why the Surrey stone was used at all. The Chaldon quarries are of inferior stone in thin beds, interstratified with useless material which had to be quarried with it but rejected and stacked in disused parts of the underground galleries. The stone beds are inclined at up to 20°, giving rise to severe problems with underground floodwater. The stone is badly weathered and fractured at its outcrop, as a result of its geological context and geographical position in the part of southern England severely affected by periglacial conditions during the last Ice Age. The quarry mouths are at the foot of the high, steep escarpment of the North Downs hills, which form the first obstacle in a 32 km overland route to the River Thames, where almost all of the stone went. The stone was not used in local vernacular architecture until about 1790 onwards. The geographical distribution of the stone in use hardly extends at all southwards from the quarry mouths into the Weald, but takes in Eton College and Windsor Castle upstream on the River Thames; Hertford Castle and a Norman chapel at Old Harlow to the north of London; Chelmsford Cathedral and numerous parish churches on the rivers and coast of Essex; Rochester and Canterbury Cathedrals, Leeds Castle and numerous lesser edifices on the River Medway and around the Kent coast. Once on water, the stone was widely distributed.

At mainland European quarries, such as those at Maastricht (Holland) and Caen (France), there is a very different picture. Beds of stone of good quality could be worked, with little or no waste, to depths of 4-7 m. The beds are almost horizontal, and underground water posed no problems. Transport by water (the River Maas in Holland, and the River Orne and English Channel coast at Caen) was possible right from the quarry mouths. It remains to be investigated whether the fluctuations in Anglo-French relations during the Middle Ages can be related to periods of use or disuse of the Caen and Chaldon quarries for stone for the finest decorative work in the most important buildings in London and southeast England. Did we use the English stone only when we had to?

REVIEWS AND RECENT PUBLICATIONS

The Chalk Tunnels of Norwich

This paper by Malcolm Atkin has recently been published in Norfolk Archaeology 38 (3), 313-20 (1983). A location map, and mine plans and sections are included, as is a list of documentary sources.

P.W.S.

Studiegroep Onderaardse Kalksteengroeven formed in Netherlands

In 1982 this new group for the study of underground limestone quarries in the Netherlands was formed and is now, in place of the mainly caving organisation Speleo Limburg, in exchange membership with Subterranea Britannica. Based on the natural history museum in

Maastricht, the SOK contact for SE is Eef Smitshuysen of Mergelweg 11, 6212XA Maastricht, The Netherlands.

The first two issues of the SOK Mededelingen are now published (a third is expected shortly), and contain articles (in Dutch) as follows:

Het onderaardse landschap als cultuur-monument: 1, 5-10 (1982) by Jacques Diederen

Groevenbeneer in Noord-Frankrijk: 1, 11-34 (1982) by Ton Breuls

SOK vleermuistellingen 1982/1983: 2, 5-12 (1983) by E. de Groot

Karst in Limburg: 2, 13-16 (1983) by Eef Smitshuysen

Onderaardse kalksteengroeven van Belgie (etc): 2, 17-23 (1983) by T. Breuls

De Cluysberg te Bemelen kultuurhistorische aspekten: 2, 24-29 (1983) by H. Hillegers.

P.W.S.

Underground Geology and Storage: a review with reference to Scotland by G.I. Lumsden and others.

HMSO: Institute of Geological Sciences Report 78/31 (1978), ii + 18 pp ISBN 0 11 884095 9 £1.00

This short (20 pp) review draws heavily on Rockstore 77 (1978) and lacks detailed data for specific Scottish sites. It is concluded that "the United Kingdom, particularly Scotland, offers great potential for the development of storage of all kinds in rock". Intrusive igneous rock masses are seen as "generally favourable" and better-suited than other rock-types. Advantages of underground installations include potentially cheaper construction costs, lower operational costs where temperature stability is important, lower maintenance costs, higher safety factors, high security levels "including protection against terrorism and immunity from nuclear attacks", and "environmental advantages".

"Throughout history map-making has kept pace with exploration and development but now the challenge of major underground development demands new thinking from the geologist with emphasis on three-dimensional analysis and portrayal".

Of the 55 references cited, no fewer than 33 are from the three (very expensive) Rockstore 77 volumes.

Reference: Bergman, M., (ed): Storage in excavated rock caverns. Rockstore 77, Proc. 1st Symp., 3 vols., Stockholm, 1978.

P.W.S.

Caves and Tunnels in South-east England: H. Pearman (ed)

Records Chelsea Speleological Soc. Vol. 12 (1983): (ii) + 68 pp ISSN 0309-409X £2.50 from P. Spink, 22 Hampton Court Avenue, East Molesey, Surrey.

This is the latest of the Chelsea Society's (and, almost exclusively, Harry Pearman's) volumes of descriptions of underground sites in south-east England. Information is collated from many sources, including not a few S.E. members. Of the sites described in this volume there are 17 in Surrey, 14 in Kent, 9 in London, and from one to four in each of Berkshire, Buckinghamshire, Cambridgeshire, Essex, Hertfordshire, Middlesex (as was), Suffolk and Sussex.

The kinds of site described include grottos, fernerys, control centres, sappers' tunnels, deneholes, World War II shelters, mines (for chalk, coal, fullers earth, hearthstone, sand, etc.), tunnels, undercrofts, crypts and so forth.

There are some 26 maps, plans and diagrams; and a bibliography of about 40 entries. Contributions range from a 5-line extract from the Bexleyheath & Welling Observer to several-page contributions (reprinted with permission) from other sources on sites such as The Hermitage (Berkshire), Cawley's Hearthstone Mine at Betchworth (Surrey), Shillinglee Park Tunnel (Sussex), Pinner Chalk Mine (Middlesex), Ramsgate World War II shelters (Kent), and Shenley Chalk Mines (Hertfordshire).

As usual with this series, the volume is an indispensable source-book on underground structures in south-eastern England.

NEWS AND REPORTS

Further Grant Aid for Investigation of the Chaldon-Merstham Quarries

Subterranea Britannica has been awarded a further grant of £100 for the survey of the subterranean building-stone quarries at Chaldon and Merstham, in Surrey.

A 1:500-scale plan is in course of preparation, showing in detail the estimated total of 17 km or so of tunnels; over 5.5 km have already been surveyed.

The latest grant, from the Lloyds Bank Fund for Independent Archaeologists, is to be devoted to producing a photographic record of underground features and of buildings and architectural features in which the stone was used; and also for specialist equipment needed in connection with access to the underground workings (wire ladder and belay).

The earlier grant, also from the Lloyds Bank Fund, was used to purchase the magnetic compass, tapes and clinometer used in the surveying.

It is Subterranea Britannica's hope that current discussions with the Ancient Monuments Inspectorate will result in the quarries being scheduled as a statutory Ancient Monument as they are, in part, of Mediaeval date and are believed to have considerable and important archaeological potential.

29 February 1984 Paul W. Sowan

National Stone Centre

A National Stone Centre is to be launched, based at Wirksworth in Derbyshire. This is evidently to be a trade as well as research centre, and there is considerable commercial backing for it. All forms of quarried and mined stone are to fall within its terms of reference and Subterranea Britannica's interests in, for example, mined limestone and subterranean building-stone quarries are recognised. It appears there may be some scope for collaboration in connection with these commodities and their study. The setting-up of the Centre was the subject of a brief note by Tony Cross ("National Stone Centre launched") in Geological Curator 3 (9), 565-66 (1983). A prospectus, press release, etc. are available from Ian A. Thomas, Secretary, c/o County Planning Department, Derbyshire County Council, County Offices, Matlock, Derbyshire DE4 3AG (0629-3411, ext 7162).

Paul W. Sowan

Underground Agriculture

This interesting item comes from Important for the Future, United Nations Institute for Training and Research (UNITAR), VI(4), 1981 (submitted by Deryck Laming).

Underground agricultural production is a relatively new development in the field. Underground space is available in mined-out underground mines, natural caves, and other underground areas created for a variety of purposes such as underground power stations, industries, and storage facilities. Using underground caves and abandoned mines for the ageing of wine at a constant temperature is a practice which is hundreds of years old. More recent is the development of raising mushrooms in underground space, mostly in abandoned mines. This has proved to be so attractive in a number of countries that growing mushrooms below ground is frequently eliminating the growing of them above ground.

In a number of abandoned mines, especially in colder areas, tree seedlings are grown. The data available show that the costs are often half the cost of growing seedlings above ground, the success ratio is very much higher and few of the seedlings grown in the unchanging climatic conditions underground die when they are transplanted above ground.

Mushrooms, tree seedlings and other crops enjoy certain advantages underground which perhaps are not immediately apparent. There are no animals to attack the crops; nor are there insects, and so no insect spraying is required. The virtually uniform year-round temperature allows a much faster crop growth than above ground, except in tropical areas. The latest and the most recent development in underground agricultural production is the growing of fish, especially trout. With a steady year-round temperature, it has been shown than trout can be raised at a more rapid rate.

Though most of the agricultural crops grown underground require artificial light, which is an additional cost, the advantages are so significant that underground agricultural production is often cost-effective when all factors are included. Moreover, the controlled environment which can be achieved underground can produce safe crops unpolluted by pesticides or other chemicals which a farmer may use in above-ground agriculture.

Clearly, not all crops can be grown underground with present technology, nor are all abandoned mines suitable for underground agriculture. But wherever there are abandoned mines or other underground areas, their possible utilisation for agricultural production purposes should be investigated.

Report on the East Kent Study Weekend: 22nd-24th June 1984

If you lift up a manhole cover in the Dean of Canterbury's garden, crawl down the mediaeval drain thus revealed for about 200 yards, you can have the pleasure of emerging on the lawn in front of Canterbury Cathedral, covered in black mud and alarming all the tourists. Quite a number of the more adventurous members of the East Kent Study Weekend in June tackled this route, and the effect on the tourists was most rewarding to watch!

This was not the only fascinating underground feature to be visited on the Study Weekend; in fact there is not space enough to describe them all. The most inaccessible was the 1880s Channel Tunnel, driven parallel to the cliff-line between Folkestone and Dover, which was visited at night by a few of the party energetic enough to tramp the mile of beach to reach the entrance. This tunnel was mechanically bored through chalk and appeared to be only a pilot tunnel of about 2 m diameter, remarkably well preserved after 100 years and showing only a modest amount of flooding.

Some of the party went to see the Margate caves, described later in this Bulletin; and several other sites written up in past issues were also visited. The chalk mines at Eastry were the last stop on the Sunday afternoon, narrow passages and bell-shaped pits, many with exotic wall paintings. We had seen Dover Castle, with dungeons and traps for the unwary. Air raid shelters riddle the cliffs of Dover, and these were reached through somebody's back garden shed (after passing through the kitchen and scullery, of course).

Another tunnel, once used by trains and subsequently as extensive air raid shelters, was entered near Ramsgate; we all dutifully climbed a set of crumbling concrete stairs to the underside of a sealed exit, and then set off for a further 500 m to peer through another sealed door at the end of the tunnel, close to the beach. How different it looked, after a cup of tea, to see the same door from the outside; two utterly different worlds.

News and Reports (continued)

On Saturday morning, visits were made to Napoleonic war defences in West Cliff, Dover, extensive tunnels and fortifications, part above and part below ground. We were accompanied by a young lad who obviously spent most of his spare time in them and knew them inside out. Before leaving the site we teetered across a rusted-out bridge to get to an old drawbridge-housing that still showed remains of the mechanism.

It was not all hard work and muddy faces on the study weekend, however; there was plenty of time to eat, drink and be friendly with each other, as is always the case on these occasions. At the crowded dinner on the Saturday evening, wine and good food went together to make us all contented, so much so that we hardly noticed that there had not been room for organiser Valerie Bannister to find a seat!

Our thanks to Valerie and all the others who made the weekend possible - it must have taken a lot of work to organise it.

Deryck Laming

Advance Notice: Societe Francaise d'Etude des Souterrains - Symposium
6-8 July 1985, at Doue-la-Fontaine, 49700 (Maine et Loire), France

Programme: Mornings: papers in the Salle des Fetes; Lunch: at Restaurant "Le Relais"; Afternoon: depart to visit the Angevins Souterrains at Deneze-sous-Doue, the district of the Caverne aux Sculptures.

The Doue-la-Fontaine Festival of Photography is being held at the same time as this symposium, and it is recommended that hotel reservations at Gennes should be made before the end of 1984. Local information bureau (Syndicat d'Initiative): Marie de Gennes-les-Rosiers 49350 (telephone (41) 59 08 80) and Hotel de Ville, Doue-la-Fontaine, 49700 (telephone (41) 59 18 53). Restaurant "Le Relais" at Deneze (telephone (41) 59 21 56).

Hotels at Gennes:
De la Loire des Dames Barreau, Avenue des Cadets de Saumur (51 81 03)
L'Aubergade, Avenue des Cadets de Saumur (51 31 07)
Les Naulets d'Anjou, Avenue de la Croix Mission (51 81 88)
Au Lion d'Or, Avenue de la Republique (51 81 23)

Camping: at Gennes, on the banks of the River Loire, and at Doue-la-Fontaine.

Information from: F. Nollent, 7 Rue Dupanloup, 45000 Orleans, France.

HOW TO JOIN SUBTERRANEA BRITANNICA

Membership of Subterranea Britannica is open to all those interested in the study of all kinds of man-made and man-used underground features.

Meetings and visits are held several times a year: formal Day Conferences in Cambridge twice a year, occasional day visits to underground sites of interest, and an annual Study Weekend in areas of particular significance and historical interest.

Annual subscription rates are:

Individual membership £4.00; joint husband/wife £5.00; young people (14-18 years) £2.00; full-time students £2.00; corporate membership £10.00.

Application forms are available from the Secretary, Paul Sowan,
96a Brighton Road, South Croydon, Surrey CR2 6AD.

MARGATE CAVES

Roger J. Morgan

The Margate 'caves' are situated near Holy Trinity Church, in Northdown Road and lie under the site of the former vicarage and its garden. They are described in 'Historic Margate' by George E. Clarke, 1965, a reprint of which is sold as a souvenir, including a plan, and following description is condensed from this pamphlet.

The caves were discovered in 1798 in the grounds of Francis Forster's newly built Northumberland House, when broken into accidentally by his gardener. A grating now marks the spot. Forster was an eccentric, and employed a local craftsman named Brazier to decorate the interior with paintings, carvings and statues.

With the building of the church and vicarage on the site, the incumbent Canon Pryor constructed access stairs from the garden in 1907, cut a new connecting passage to two of the chambers with top access in 1908, and in 1910 discovered and cleared a well. The romantic interpretation of it in 1912 by Sir William Bull (MP, scholar and antiquary) as a natural cave enlarged by Saxons for religious use popularised it as a tourist attraction. In 1914 a new entrance was made, possibly as an air-raid precaution, from the cellar of the vicarage. However, having survived, the building was destroyed in the Second World War, and the levelled site leased by F.G. Gardner Esq., lessee of Chislehurst Caves and Godstone Hearthstone Mine. In 1958, with the assistance of students from the local Art College, the debris was removed, and the 'caves' are now open to the public in the summer months.

The accompanying sketch plan and sections are compiled from synthesising and reconciling the photographs, plan and description in the guide. The 'caves' consist of the usual rectangular grid of arched passages about 12 feet (3.6 m) high, characteristic of chalk mines (mistaken for ecclesiastical vaulting by antiquarian visitors), with a secondary 'take' from the floor dropping the level a further 12 feet to a total depth of about 40 feet (12 m) beneath the surface; the extreme length of the north-south passage is about 100 feet (30 m). The modern access is from the north, via a cutting and the 1914 dog-legged stairs connecting the cellars of the former vicarage. Everywhere may be seen Brazier's ornamentation - paintings of two George III soldiers, a crocodile, lion, elephant, dog, monkeys, donkey, fox-hunt, dog and kennel; obliterated carvings of a figure and a maltese cross; an ammonite; and possibly a statue. The latter stands on the 6 feet (1.8 m) high bench left by the excavation method at the east end of the northernmost east-west passage, identified in the guide as an altar.

The most interesting features, however, are the oval chambers with an internal finish smoother than the pick-marked walls seen elsewhere; the central pits; and the original top access. These are dug into the western portion of the original floor level, omitted from the 'second take'. Identified as dungeons and torture chambers in the guide, they are in conjunction with the 46 feet (14.0 m) deep well - whose waters, said to be brackish and tidal, are however probably above sea-level. Of the two cavities, the larger is about 20 feet (6.1 m) high and can be accessed via the 15 feet (4.6 m) tunnel cut for the purpose from the lower floor level.

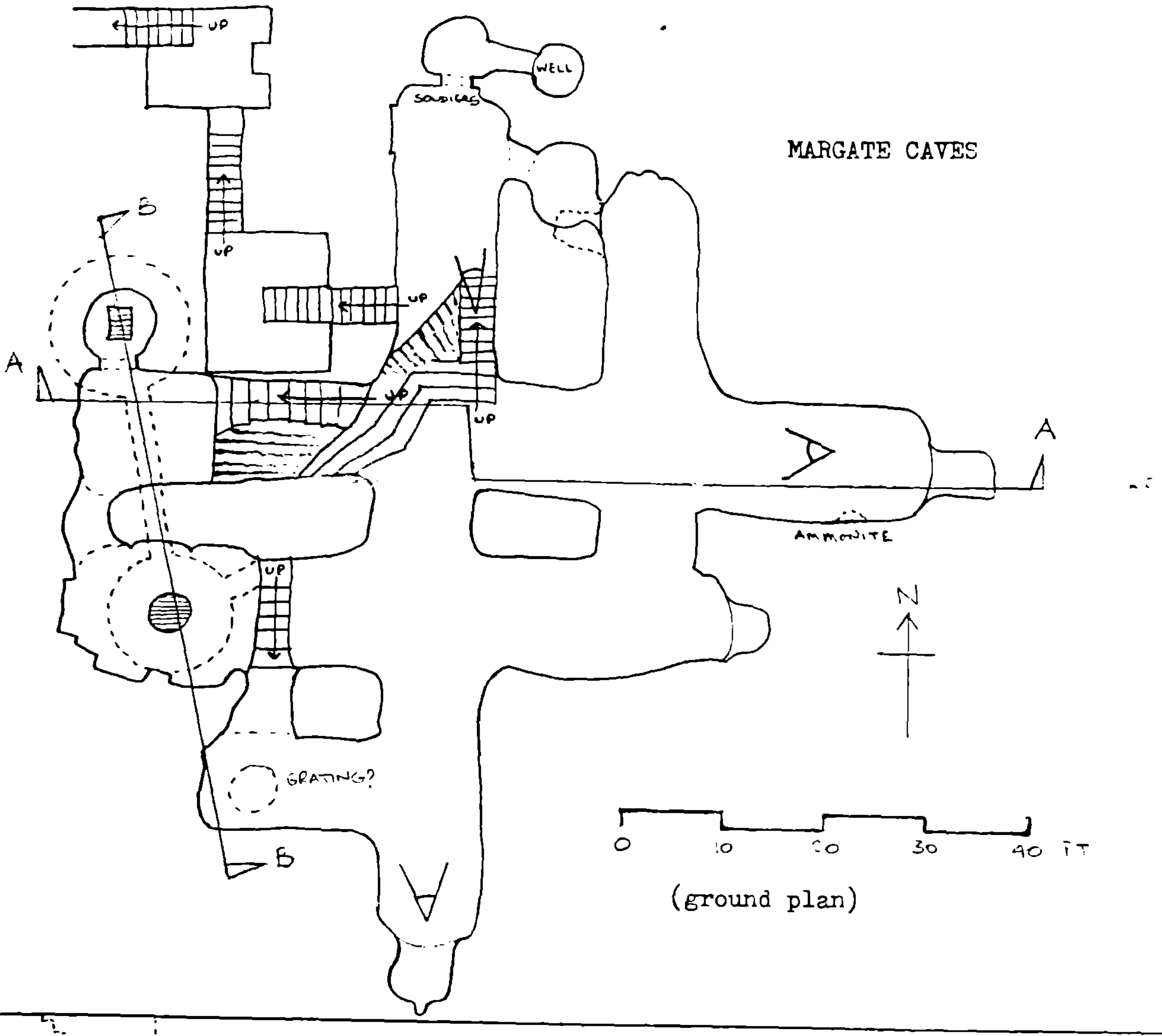
It thus seems likely that this presumably mediaeval chalk mine was modified for another function for the household of its 17th century owner, lost, and then rediscovered to be converted into a subterranean folly at the end of the 18th century, and has evolved into the romantically embued showcave we see today.

Reference :

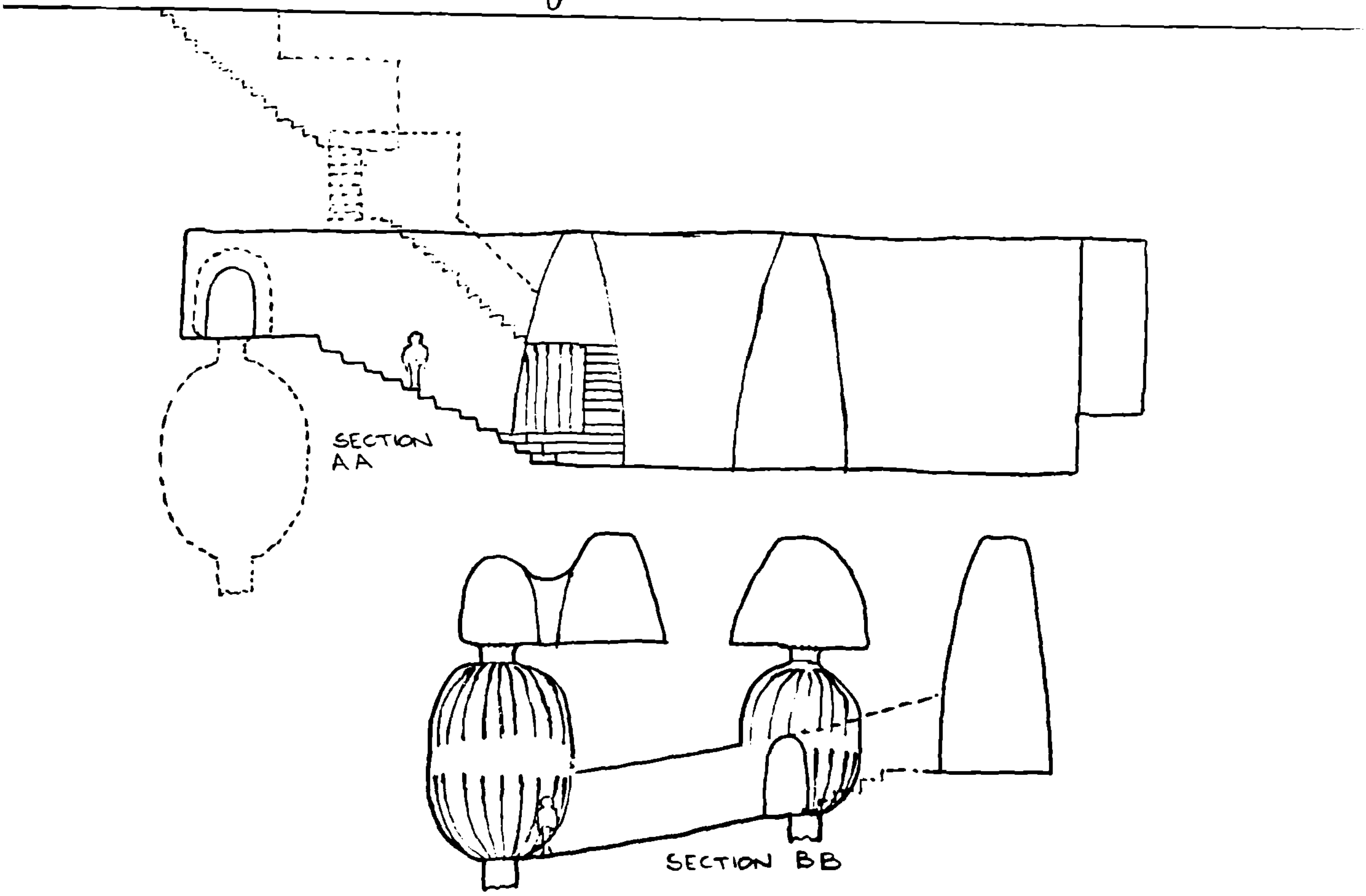
Clarke, George E. (1965), Historic Margate. Second edition. Reprints of a series of articles published in the Isle of Thanet Gazette.

(Since this article was written, Sylvia Beamon has visited the site and recognised the chambers as likely to have been malt kilns, a conclusion also verified by two members of the Nottingham Historical Arts Society during the East Kent Study Weekend. Margate was known to be a malting town).

MARGATE CAVES



(ground plan)



R. Morgan, 1984
(after G.E.Clarke)

THE TONBRIDGE SEWERS OF 1837-40

Paul W. Sowan

A recently published paper by Barker-Read on public health in 19th century Tonbridge, Kent (1982), gives some fascinating details of the system of sewers constructed by the Vestry in that town between 1837 and 1840. Partial plans of the system are held by Tonbridge & Malling UDC, and road excavations have from time to time allowed access to the sewers themselves. These "seem to indicate little consideration of some very elementary scientific principles which should underlie any efficient drainage, and no thought at all to possible health hazards".

"The sewers were barrel-shaped flat-bottomed tunnels, large enough to accommodate a man, for manual periodic cleaning. Their rough internal surfaces and flat bottoms impeded the flow and encouraged sedimentation. Bends were very sharp and junctions were often at right angles which further encouraged sedimentation; those draining the lower half of the town had to run a slight but definite upward course to discharge their contents. As few houses had piped water, before many years had passed the smaller sewers were choked with the contents. For ease of access they were laid immediately beneath the road surface. Occasionally cesspools or house drains leading into them were at lower levels, so that the direction of flow might, from time to time, be in the opposite direction to that originally intended. Six sewers terminated in the Medway right in the middle of the town".

Severe problems were being reported by 1854. On 29 November in that year Mr Alfred Dickens, C.E., inspected the town's sanitary arrangements, under powers conferred by the Public Health Act, 1848; he reported the following year. However, it was some 20 years or so before any concrete progress was made with constructing a new and adequate network of sewers and drains - the older system then being entirely abandoned. The new works were completed by July 1874.

To what extent this abandoned 19th century sewer system accounts for the local rumours of 'secret tunnels' reported by Bullion (1978) is not clear. But a close examination of the surviving documentation might be worthwhile, both in the solution of the Tonbridge 'secrets' and the recognition of similar systems elsewhere.

References:

Barker-Read, M., The public health question in the nineteenth century: public health and sanitation in a Kentish market town, Tonbridge 1850-1875, Southern History, 4, 167-189, 1982.

Bullion, A., The underground tunnel system in Tonbridge, Kent, Bull. Subterranea Britannica, 8, 11-13, 1978.

Dickens, A.L., Report on the Sanitary Condition of Tonbridge, 1855.

Neve, A.H., Tonbridge of Yesterday, 1933.

Tonbridge: Nuisances and Sewer Committee Minutes etc - details are given in Barker-Read.

HOBSON'S CONDUIT: Part I

E. Gray

Hobson's Brook is the leat flowing past the University Botanic Gardens that visitors notice on entering Cambridge along the A10 from the south (Gray, 1977). This section of it is called Hobson's Conduit; it terminates in an open cistern, the Conduit Head, at the corner of Trumpington Road and Lensfield Road, where the distribution of the water to the various courses was achieved. A handsome Jacobean fountain now stands here, originally placed in the market place in Cromwell's day, when householders collected their domestic supplies from it in buckets. The main source of the water used to be the Nine Wells, a group of chalk springs between two and three miles due south of Cambridge, but their output is much less abundant than formerly. The spring waters originally ran into a stream, the Vicars Brook, flowing due north to the Cam along an old river bed but, in 1614, they were led down cuttings inserted in the brook which maintained a current right down to the present site of the Botanic Gardens. The original course of the Brook was thus lost. Dr Stephen Perne, University Vice-Chancellor, originally suggested the scheme, but the new supply became known by the name of Hobson, the Cambridge carrier. Its original purpose was to flush out the Town (King's) Ditch. This was a dry moat linking the two arms of the Cam that enclosed mediaeval Cambridge.

Not until 1574 did Dr Perne write to Lord Burghley, University Chancellor, proposing that the Nine Wells waters might be brought into the town to flush it out. Lord Burghley was also Treasurer to Queen Elizabeth, thus in a position to obtain permission from the Crown. The work was completed by the end of October 1610 and cost £100. Four years later, after the ditch had literally been liquidated, the spring waters were utilised to give Cambridge a constant fresh water supply. It continued to serve this purpose for 250 years.

Dr Gray's primary interest and research was into the purity of the water and was able to confirm A.H. Hassall's similar work of 1852. One in particular of the Brook's indigenous population of microbes common to arable land (adapted to cold alkaline waters), appeared in the water every Autumn. In spring and summer the water was filled with Gram-negative rods believed to come from the roots of ripening wheat. These were eaten by animalculae, then fostered by a low temperature and an alkaline reaction of the water in turn destroyed the bacteria of pollution, also Gram-negative rods, therefore purifying the stream. Due to changes in agricultural practices during the last decade the balance has altered.

Reference :

Gray, E.A. (1977) Hobson's Conduit - The story of a Cambridgeshire chalk stream. Bird's Farm Publications, Cambridge.

HOBSON'S CONDUIT: Part II, Notes on the Underground Sections

(by courtesy of the Trustees of Hobson's Conduit)

Sylvia P. Beamon

A further channel was constructed in Hobson's Conduit in 1631 to convey water from the Conduit Head to Emmanuel and Christ's Colleges. It was in the form of an open ditch with several bridges, but was later culverted. On the recommendation of the Commissioners of Sewers the colleges allowed a proportion of the water to flow into the street at the entrance to Emmanuel College and to run down St Andrew's Street to provide a further flushing point for the King's Ditch near Christ's Gateway. The present street runnels in St Andrew's Street are all that remain of the flushing system, and the water now discharges into the Hobson Street surface water sewer.

The system ultimately comprised four runs from the Conduit Head:

Course No 1. The water leaves the Conduit Head through a controlling penstock and flows through glazed stoneware pipes laid along Trumpington Street to a point opposite St Peter's Terrace where it rises up into two open channels and flows down both sides of Trumpington Street to the corner of Mill Lane. There it flows into the surface water sewer which discharges into the River Cam at the Mill Pit.

Course No 2. This was the original course used for flushing the King's Ditch in the form of an open ditch, but was gradually culverted until totally enclosed, with the exception of the length in front of Addenbrooke's Hospital which was retained as an ornamental pond. From this pond a 4-inch diameter cast iron pipe fed two tanks which were used for flushing the hospital drains. One of these tanks is still visible and the pipe can also be traced at various places in the hospital basements. (It had other branches not discussed here).

Course No 3. This length, which dates from 1631, leaves the Conduit Head via a penstock on the east side of the pool and runs along Lensfield Road to Gonville Place. Opposite the Roman Catholic Church is a chamber with a sluice gate for flushing the East Road Sewer (formerly combined but now used for surface water only). This gate is no longer usable.

After passing under the corner of the Perse School grounds it flows along Regent Terrace, at many points being located under buildings. A dipping hole for drawing water still exists on this length.

In a manhole outside Emmanuel College the course divides. One branch feeds the St Andrew's Street runnels which ultimately discharge into the sewer in Hobson Street. The other branch feeds the two ponds in Emmanuel College. At the northern end of the Great Pond the flow again divides. The westerly branch feeds the College swimming pool, the overflow from this discharging into the surface water sewer. The easterly branch passes under the footpath opposite the end of Emmanuel Road and then along Drummer Street to the end of Milton's Walk, where, in a series of inspection chambers, the flow is divided between the pond in the Master's Garden of Christ's College, the College swimming bath and an overflow pipe in Milton's Walk.

Originally this course was almost entirely an open watercourse, but it has been gradually culverted. The present location and construction are still largely the same as given in a Report dated 1856 by Mr G.S. Smith.

Course No 4. This is the length constructed in 1614 to feed the fountain on Market Hill via Tennis Court Road and St Andrew's Hill and is the only one which is under pressure for its full length.

As a result of the great fire of 1849, the Market Hill was enlarged, and in 1856 the old fountain was removed to Lensfield Road. A new fountain was constructed in the centre of the square. This was provided with four underground flushing tanks for scouring the sewers which radiated from the square. These ceased to be used when the new foul sewers were constructed at the end of the 19th century.

The construction of the Conduit system is of considerable interest from an engineering point of view. Water is abstracted from the natural watercourse near Barrow Road and conveyed by an artificial and, in places elevated, 'canal'. Below the point of abstraction, the natural watercourse is now called Vicars Brook and above it is Hobson's Brook. It is likely that some realignment and regrading was carried out above the point of extraction. A 6-inch diameter pipe provides an overflow from the brook into the ditch.

Valve chambers originally existed at Bene't Place, Lensfield Road (now superseded by the Lensfield Road-Tennis Court Road diversion) and St Andrew's Hill (still in use). In addition there were 'tanks', probably used as settlement chambers, on the site now occupied by the New Museums and the Lion Yard Car Park. No trace can be found of these today.

The water from the Conduit was utilised for flushing the sewer at a number of points. In particular, special provision was made at Hyde Park Corner, where a penstock was provided to discharge water into the Gonville Place sewer, and at Market Hill. In the latter case, four underground chambers were constructed to act as flushing cisterns for various sewers which terminate at that point. With the improvement of the sewerage system of the town these devices fell into disuse.

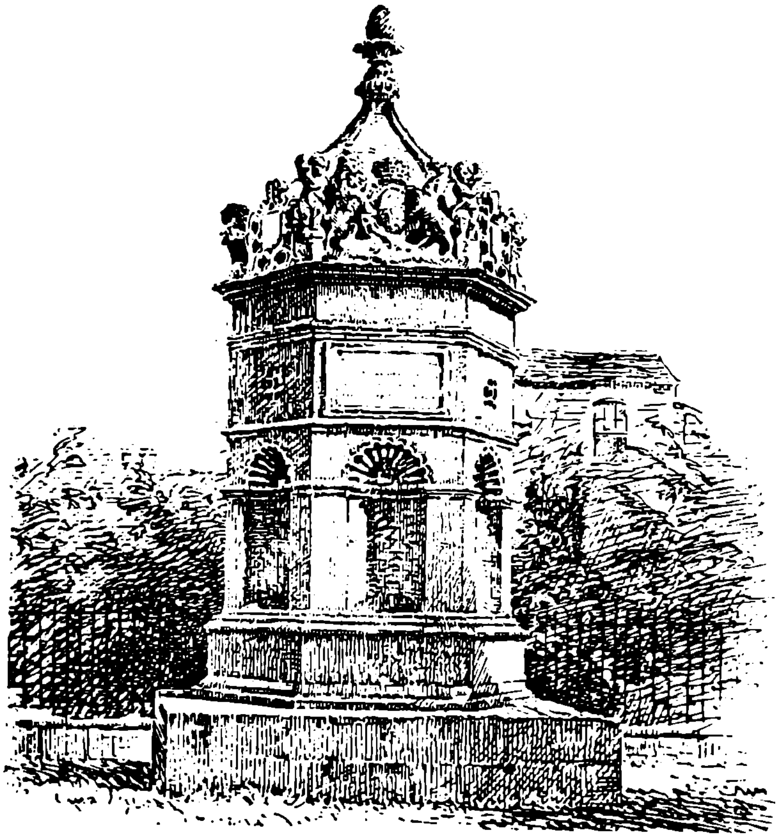
A COMPARISON OF UNDERGROUND DWELLINGS IN THE EASTERN MEDITERRANEAN AND ANATOLIA: SANTORINI AND CAPPADOCIA

Captions to illustrations (pp. 4 - 10)

1. Map of Eastern Mediterranean
2. Map of Santorini
3. Temperature moderation in an earth-sheltered dwelling on Santorini (ref. 5)
4. Cross-section of Santorini dwelling, showing ventilation openings (ref. 5)
5. Plans of house in Aucilar, Cappadocia (ref. 4) with diagrammatic representation of seasonal use patterns.

The cartoon is reproduced with kind permission of 'CLEW' and Lighting Equipment News from their issue dated August, 1983.

'Know something, Paul ? We're probably the first human beings to have set foot here for a hundred million years.'



Cambridge

Hobson's Conduit